

SOME RESULTS OF BIOTECHNICAL TESTS AND
BIOLOGICAL RESEARCH ON "KOSMOS-368"

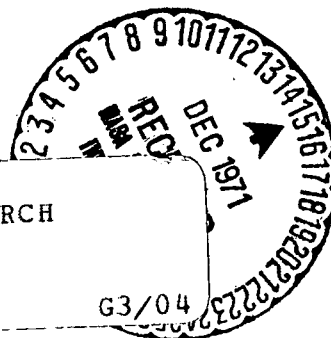
Ye. A. Il'in

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SOME RESULTS OF BIOTECHNICAL TESTS AND
BIOLOGICAL RESEARCH ON "KOSMOS-368"

Ye. A. Il'in

ABSTRACT. Test performed on "Kosmos-368" showed that weightlessness has almost no effect on cells in a state of rest. The characteristics of equipment to conduct biological studies in prolonged space flights are defined more accurately.

/1^{*}

To develop general biological bases and principles for medical-biological control of months-long, manned space flights it is necessary to make a comprehensive study of the effect of space flight factors, especially weightlessness, on the fundamental life processes. With this aim, our country is systematically implementing a program of biological research on various spacecraft. One of these steps was the launching in October, 1970, of the artificial earth satellite (AES) "Kosmos-368," which conducted biological-technical tests of scientific-research apparatus, intended for biological research in space flights. Further study was also made of the effect of weightlessness and other flight factors on biological objects of differing structural-functional organizational levels.

The satellite "Kosmos-368" carried various kinds of units and containers with microorganisms, insects, seeds, plants, and cultures of animal and vegetable cells. The purpose of the biotechnical tests was to establish the possibility of using new equipment to conduct biological tests in prolonged space flights. The biological tests in the AES "Kosmos-368" were the natural extension of experiments conducted earlier in other spacecraft instruments.

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* Numbers in the margin indicate pagination in the original foreign text.

The flight of "Kosmos-368" lasted six days (8-14 October 1970). The altitude of the flight was 411 km at apogee and 211 km at perigee. The period of revolution was 90.4 min.; the inclination of the orbit was 65°. Temperature on board the satellite was maintained by a thermal regulation system between 20-23°C. The biological objects were delivered to scientific laboratories for study 24 hours after the flight ended.

RESULTS

Experiments with micro-organisms. To study the effect of weightlessness on the form and size of bacterial colonies, a microbe cultivator was used which was a cylindrical container with two removable covers. A Petri dish with E. coli K-12 and Bac. brevis bacteria was placed in this container. A special * seal protected the dish from damage during mechanical action on the cultivator case.

The premise for conducting this experiment was the research of D. Wilkens et al. (1969) on clinostats showing the effect of the gravitational field on the architectonics of microbe colonies. However, the experiments conducted by A. A. Lukin on "Kosmos-368" force one to conclude that weightlessness either has no effect on the form and size of microbe colonies, or does affect them, but only in the early stages of colony formation. In this experiment this occurred on Earth in the period between seeding the bacteria in the solid nutrient medium and placing the satellite in orbit. After the flight no mutations or changes in the sexual factor were detected in the bacterial culture. The latter, as also before the flight, was found in the bacterial chromosome in an integrated state. /3

After the flight, the effect of weightlessness on survival was analyzed, as well as the biochemical characteristics of Staphylococcus albus and its relation to antibiotics. According to the data of S. A. Chepelev, no changes

*Translator's Note: Illegible in foreign text.

of any kind in comparison with the control were detected. Therefore, under weightless conditions damage to normally balanced relations between microbes and man can be expected, evidently only because of changes in the reactivity and resistance of man. This assumption is also supported by the data of American authors to the effect that pathogenic properties of streptococci did not change during a prolonged period on the Moon.

In the flight of "Kosmos-368" studies were also conducted on two kinds of yeast cells: the diploid strain *Sacchar. ellips.* Megri 139-B and haploid *Sacchar. Baili*. These strains have been well studied radiobiologically, and considerable experience has been accumulated in conducting radiobiological experiments in space flights.

This experiment was conducted as a continuation of these studies. Before the flight some of the yeast cell culture was irradiated with gamma-rays of Co^{60} in doses from 20 to 160 kilorads and placed in ampules which were put in polyethylene racks in a special metal container. The remaining, nonirradiated part of the yeast cell culture served as a flight control and was partially used for post-flight irradiation.

The results of the experiment conducted by V. N. Benevolenskiy agree with data obtained earlier that weightlessness, evidently, has no effect on radio-/4
sensitivity and the post-radiation recovery ability of yeast cells at rest.

According to the data of V. N. Benevolenskiy, the results of the experiment with a culture of *Hydrogenomonas* (strain Z-1), irradiated with Co^{60} gamma-rays in doses from 0.5 to 6 kilorads, concurred with the results of the experiment with yeasts and showed that spending six days under weightless conditions did not lead to a change of viability and radio-sensitivity in hydrogen bacteria.

In an experiment with the single-cell water plant *chlorella*, conducted by I. V. Aleksandrova, no effect of weightlessness was detected on the productivity of the culture, cell morphology, population structure or the chlorophyll

content in the cells.

Experiments with insects. The purpose of these experiments was to study the effect of weightlessness on mutability and the development cycle of drosophila and the meal worm. The bottom of the upper cover was made of transparent material, and a special vessel filled with a nutrient medium was put in the lower part of the cylinder.

As the studies of G. P. Parfenov have shown, the general result of the experiment with drosophila on "Kosmos-368" supported the data earlier obtained that the first stage of development of drosophila occurs normally under weightless conditions.

However, in nearly a third of the drosophila individuals, anomalies in wing structure were discovered, and in the females there was also a change in the frequency of crossing-over*.

The experiment conducted by G. P. Parfenov with the meal worm showed that individuals in various stages of development (larva, chrysalis, imago), have no /5 difficulty in enduring flight conditions. Some lag in development was observed, which was more marked in larvae which were in the last stages of development during the flight. Embryonic development of the meal worm and the emergence of the larvae from the eggs occurred normally under weightless conditions. The frequency of dominant lethals did not differ from the control. Thus, the results of experiments with insects on "Kosmos-368" do not indicate that gravitation has a decisive role in the development of individuals from centrolecithal eggs.

Experiment with a culture of animal cells. Cultures of cells of Syrian hamsters (line BNK-21) were placed in flasks and Carrel dishes, some of which were put in units made of a vinyl plastic case with two removable covers. The

*Translator's Note: This designates the exchange of genes between homologous chromosomes of a hybrid.

temperature inside the unit was 20-23°C. The other part of the test culture was placed in a thermostat, in which the temperature was maintained throughout the flight in a regime of $29 \pm 0.5^{\circ}\text{C}$ by using a closed automatic regulating system.

Experimental studies conducted by F. V. Sushkov showed that weightlessness did not affect cell morphology, the regeneration rate of the cellular population, or cell division; it also did not lead to any significant increase in the percentage of chromosome aberrations. In addition, an increase was detected in mitotic activity of the cells — an extremely important fact, but one which needs verification in subsequent flight experiments.

Experiment with vegetable tissue. A culture of carrot tissue was used under non-thermostatic conditions in the same unit with a culture of animal tissue. The results of the test conducted by I. V. Aleksandrova showed that the weight of the moist biomass of the culture was 1.5 times greater after the flight than the control, and the cells of the flight variant of the tissue culture were 2.4 times larger than the control cells. The mitotic index did not change. /6

Experiments with seeds, bulbs and plants. The research objects were seeds of lettuce, and peas, bulbs of *Allium cepa* and *tradescantia* in the blooming stage, placed in units and containers of various construction.

According to the data of N. L. Delone, as a result of the six-day flight, in a number of cases a statistically reliable increase in the number of chromosome rearrangements was detected in the primary rootlets of the bulb and higher plants. Three kinds of damage were discovered in the microspores of the *tradescantia*:

1. Damage to the mitosis mechanism,
2. Peculiar kinds of chromosome rearrangements,
3. Damage to growth processes in the cell.

The above-cited damages were observed in 2-3% of cases.

In the seeds of lettuce and peas, the effect of weightlessness on the appearance of a radiation effect was also studied (pre-flight radiation at a dosage from 1 to 10 kilorads) as well as a change in seed radio-sensitivity (post-flight radiation in the same dosages). The research of Yu. I. Shaydorov et al. showed that weightlessness increased the mitotic activity of seed cells to the same degree in irradiated seeds and in non-irradiated ones. At the same time the percent of cells with chromosome rearrangements in seeds irradiated with a dose of 5 kilorads was reliably less in the flight variant than in the control. These, as well as the results of the studies mentioned above with irradiated yeasts and hydrogen bacteria, it seems to us, do not point to a final conclusion about the effect of weightlessness on radio-sensitivity and the appearance of a radiation effect in biological objects. 17

CONCLUSIONS

1. The biotechnical tests of the scientific-research equipment in the flight of "Kosmos-368" have made it possible to determine more accurately the characteristics of equipment used for conducting biological studies in prolonged space flights.

2. The results of biological studies conducted on "Kosmos-368" showed that weightlessness has practically no effect on cells in a state of rest.

3. To clarify the effect of weightlessness on actively metabolizing cells, it is necessary to develop new forms of scientific-research equipment and to perfect methods of in-flight testing.

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